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IoT Based Anti-Theft Detection Using ESP32-Cam Module

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***Abstract*: The proposed system is an IoT-Based Smart Anti-Theft Detection and Alert System utilizing the ESP32- CAM module. This system is designed to secure homes during the owner's absence by monitoring unauthorized movements across the floor using embedded pressure or vibration, and its sensors. When the system detects movement, the ESP32-CAM captures images or videos of the area and transmits them via Wi-Fi to the homeowner's email or an IoT dashboard. This real-time alert mechanism enables immediate action to mitigate and this also provides the range to potential threats. The system's compact and cost-effective design, coupled with the integrated camera and Wi-Fi capabilities of the ESP32- CAM, ensures seamless monitoring. Additional features, such as cloud storage, night vision, and mobile app integration, further enhance its usability. This smart anti-theft solution provides a reliable, scalable, and efficient method to safeguard homes against unauthorized access.**

***Keywords*: Anti-theft detection, IoT.**

1. Introduction

In today's world, home security has become a paramount concern due to the increasing rate of theft and burglary. Traditional security systems, while effective, often lack real-time monitoring and automated response capabilities. To address these limitations, IoT-based smart security systems have emerged as an innovative and reliable solution. This project presents a Smart Anti-Theft Detection and Alert System using the ESP32-CAM module. The system is designed to monitor unauthorized movements within a home and provide real-time alerts to homeowners. By integrating pressure or vibration sensors with the ESP32-CAM, the system can detect intrusions, capture images or videos, and transmit them to the homeowner over Wi-Fi. The ESP32- CAM, being a compact and cost-effective module with built- in camera and Wi-Fi functionality, serves as the core of this system. Its ability to capture high-quality images, combined with its IoT connectivity, ensures seamless and immediate communication with the user. The system not only enhances home security but also offers features like remote monitoring, night vision, and data storage, making it a comprehensive solution for modern home safety needs.

A. Proposed System

1) Anti-Theft Detection and Alert System Using ESP32

Whenever a thief enters the house and steps on the floor, the pressure or vibration sensors immediately sense the disturbance. passes on the signal to raspberry pi controller. The controller in turn processes it to be valid signal and then moves the Upon validation, the ESP32-CAM activates its camera to capture an image or video of the area where the movement was detected. If required, the camera can be mounted on a servo motor to focus on the specific area of disturbance. The captured data is then transmitted over the Internet using the ESP32-CAM's built-in Wi- Fi functionality.

The homeowner is notified in real time via email or an IoT dashboard and can review the images or videos remotely to assess the situation. This system provides a cost-effective, efficient, and compact solution for detecting and alerting homeowners to unauthorized access.

2. System Block Diagram

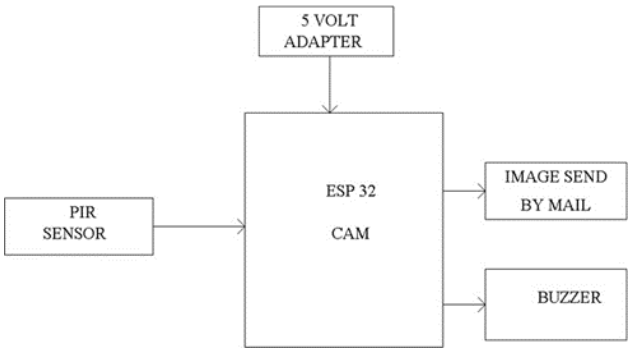

Fig. 1. Block diagram of ESP-32 camera based anti-theft detection system

3. Hardware Description

A. ESP-32 Camera

The brain of the system, the ESP32-CAM, acts like a smart watch for your home, constantly keeping an eye out for unusual activity. It is a compact microcontroller with built-in Wi-Fi and a camera, enabling it to capture images or videos and transmit them wirelessly to the homeowner. Acts as the central controller of the system, processing signals from the PIR sensor, capturing images are send to email via sources videos,

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and transmitting data It is a compact microcontroller with built-in Wi-Fi and a camera, enabling it to capture images or videos and transmit them through multiple systems wirelessly to the homeowner.

Fig. 2. ESP-32 Camera

B. 5-volt Power Supply

A 5-volt power supply (PWC) is a critical component in many electronics projects, particularly for powering low-voltage devices such as microcontrollers, sensors, and actuators. It ensures a stable and regulated voltage supply, essential for the proper functioning of components like the ESP32-CAM, servo motors, and other peripherals. A is a critical component in many electronics projects, particularly for powering low- voltage devices such as microcontrollers, sensors, and actuators. It ensures a stable and regulated voltage supply.

Fig. 3. 5 Volt power supply

C. PIR Sensor

A PIR sensor is a motion detection device widely used in security and IoT systems. It detects motion by measuring infrared (IR) radiation emitted by objects, particularly warm bodies like humans or animals. When an object passes through the sensor's field of view, it triggers a signal indicating movement. The sensor does not emit any radiation; it only detects infrared radiation emitted by objects, making it energy-efficient and reliable. Some PIR sensors allow adjustment of sensitivity and signal delay, providing flexibility for different use cases. Typically, PIR sensors can detect motion within a range of 5 to 12 meters and at an angle of around 110 to 180 degrees.

Fig. 4. PIR Sensor

D. FTDI Driver

The FTDI driver is essential for programming and communicating with devices like the ESP32-CAM or other microcontrollers that rely provides the on UART (Universal Asynchronous Receiver-Transmitter) communication. FTDI drivers are used to interface USB ports with devices that have serial communication capabilities, enabling a computer to program or communicate with microcontrollers via USB Converts USB data into serial UART communication that microcontrollers can understand Once installed, the driver automatically configures the USB device as a serial port, making it easy to use with development environments like Arduino IDE.

Fig. 5. FTDI Driver

E. Node MCU

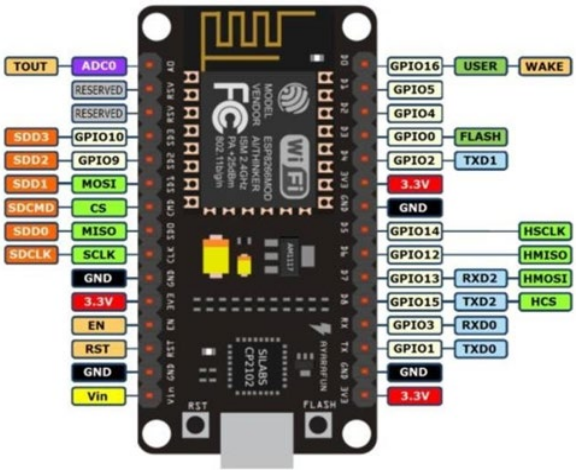

Fig. 6. Node MCU

It features the ESP32 microcontroller from Espressif Systems, which offers both Wi-Fi and Bluetooth connectivity. The ESP32-CAM board includes the ESP32 chip along with an integrated camera, making it ideal for applications such as surveillance, image recognition, and remote monitoring. The firmware for the ESP32-CAM utilizes the Arduino IDE or Espressif's ESP-IDF (Espressif IoT Development Framework), and supports various programming languages such as C/C++. With its powerful dual-core processor and multiple I/O pins, the ESP32-CAM is well-suited for handling both communication tasks and image processing in IoT applications.

4. Software Description

In the proposed IoT-based Anti-Theft Detection and Alert System using the ESP32-CAM, the software plays a crucial role in handling sensor data, controlling the camera module, and sending alerts to the homeowner. The system integrates multiple components, including the PIR sensor for motion detection, the ESP32-CAM for image capture, and the buzzer for immediate audible alerts. The software manages these elements through a series of steps to ensure smooth operation and real-time response. Although Raspbian is primarily the efforts of Mike Thompson (mpthompson) and Peter Green (plug wash), it has also benefited greatly from the enthusiastic support of Raspberry Pi community members who wish to get the maximum performance from their device.

The development of this project utilizes the Arduino IDE, which is compatible with the ESP32-CAM. The Arduino IDE provides an easy-to-use environment for writing and uploading code to the ESP32, using languages like C/C++. The software leverages various libraries to interface with the hardware components. ESP32 Camera Library: For controlling the camera and capturing images when motion is detected PIR Sensor Library: For detecting motion via the PIR sensor. Buzzer Control: To sound an alarm when unauthorized motion is detected. Motion Detection: The software continuously monitors the PIR sensor for motion. When the PIR sensor detects movement, it sends a signal to the ESP32-CAM.Camera Activation: Upon detecting movement, the software activates the camera using the ESP32 Camera library. The camera is then programmed to capture an image of the detected area. The camera is controlled through pulse-width modulation (PWM) to adjust its position (if using a servo motor to control camera direction) and to capture images efficiently.

A. Python

Python is a versatile, high-level programming language designed for ease of use and rapid development. It is known for its simple syntax and powerful capabilities, making it an excellent choice for beginners and professionals alike. Python supports various programming paradigms, including object-oriented, procedural, and functional programming

Simple and Easy to for the people who wants to Learn: Python's syntax is designed to be readable and intuitive, making it accessible to beginners and experts. Its simplicity promotes faster development and debugging.

Dynamic Typing Python is dynamically typed, meaning that variable types are determined at runtime, which allows for greater flexibility in coding.

Interpreted Language Python code is executed line by line by the Python interpreter, making it easy to test and debug small parts of your program without compiling the entire code. it accessible to beginners and experts. Its simplicity promotes faster development and debugging.

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5. Architectural Flow of System

Following Figures shows the architectural flow of system installation process and working of the proposed system which will lead to prevention of Theft.

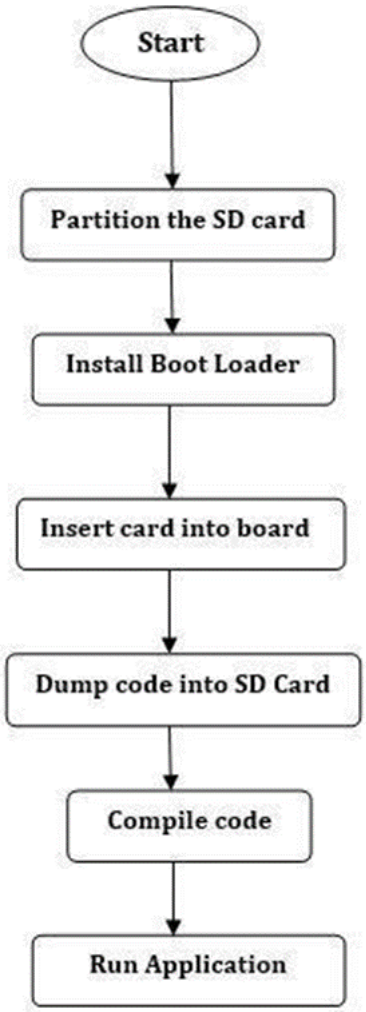

Fig. 7. Installation process

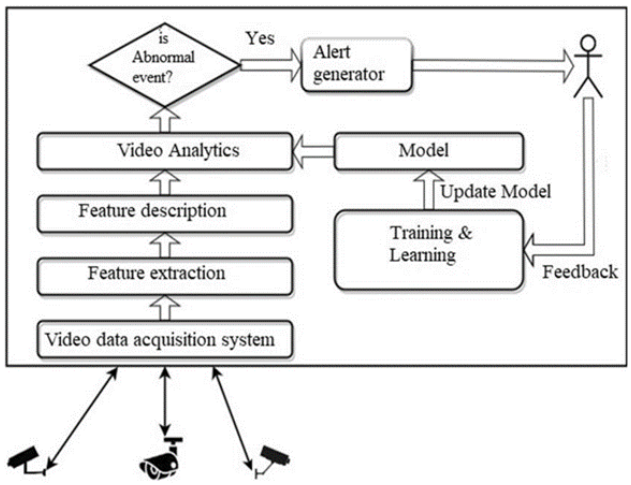

Fig. 8. Flow chart

6. Working and Result

In this project, the ESP32-CAM (model) is used as the core of the system. This proposed system is an intelligent security solution that eliminates the need for continuous human monitoring. Therefore, any manual intervention is not required. The system continuously monitors the status of the area (such as a house or store) using sensors to detect if anyone is entering the premises. Once motion is detected, it sends an alert message to the homeowner along with live images, captured by the camera, after rotating it to different angles for better coverage. In this security system, human movement is detected by a PIR sensor (Passive Infrared sensor), which is used to identify changes in infrared radiation (heat) from the human body. Upon detecting motion, the system triggers the camera to capture images and notify the home owner of potential intrusion in real-time. The main aim of this project is to make and automated security system for Banks and jewelry shops. The project consists of Raspberry Pi with sensor and camera. The whole system is placed in that place. If system detect someone in Bank/shop it sets the capture the live images and sent it on e-mail. it sends an alert message to the homeowner along with live images, captured by the camera, after rotating it to different angles for better coverage. In this security system, human movement is detected by a PIR sensor (Passive Infrared sensor), which is used to identify changes in infrared radiation (heat) from the human body. Upon detecting motion, the system triggers the camera to capture images and notify the home owner of potential intrusion in real-time. The main aim of this project is to make and automated security system for Banks and jewelry shops.

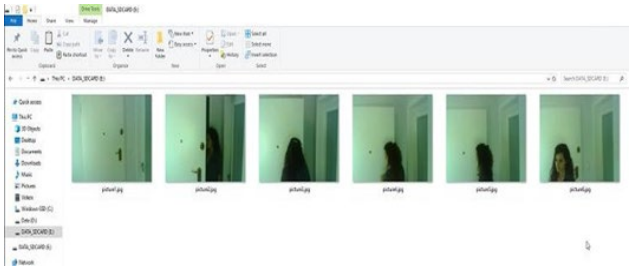

Fig. 9. Real time images

A. Advantages

The system instantly alerts homeowners whenever unauthorized motion is detected. The homeowner receives an email with live images, ensuring that they can take immediate action. With internet connectivity, the system allows homeowners to remotely monitor their property from anywhere in the world, using their smartphone or computer

B. Applications

1. Jewelry Shops
2. Army Surveillance
3. Bank Locker Room
4. Museum Security
5. Home Security

7. Conclusion

The IoT-based Anti-Theft Detection and Alert System using ESP32-CAM offers a reliable and efficient solution for enhancing home security. By utilizing a combination of PIR motion sensors, the ESP32-CAM module, and real-time alert mechanisms, this system eliminates the need for constant human supervision, providing an intelligent and automated response to unauthorized access. When motion is detected, the system promptly captures images using the ESP32-CAM, rotates the camera to capture a clear view of the intruder, and sends the images and alerts to the homeowner via email. This real-time notification, combined with the ability to monitor the premises remotely, ensures enhanced security and peace of mind for the homeowner.

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